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RAMIE, A FIBER-YIELDING PLANT

By Lyster H. Dewey
Senior Botanist, in Charge of Office of Fiber Plants, Bureau of Plant Industry

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NAMES

The name "ramie" is generally used by English-speaking people to designate the plant *Boehmeria nivea*, with leaves snow white on the under surface, and also the fiber obtained from this plant. The same name is used with the same meaning in the French, Italian, Spanish, and Dutch languages and with the slight change to rameh in the German language. The name is of East Indian or Malay origin and is said to have been used originally to designate *B. nivea tenacissima*, a tropical form with thin leaves, green on both surfaces, less hardy, and rarely cultivated.

The name "rhea" is used in India to designate both forms, but more especially the introduced form with leaves white on the under surface, known elsewhere as ramie. The name rhea is also used, especially by English authors who have been in India, to designate the white-leaved form that is found in cultivation there. In the London fiber market the name ramie is used to designate the fiber from China or Japan, and the name rhea for the fiber from all other sources. In recent years there have been no quotations under the name rhea.

China grass is the hand-cleaned but not degummed fiber, rather stiff, greenish or semitranslucent parchmentlike yellow, as it comes on the market. The name is also incorrectly used to designate the plant.

In China where ramie is most extensively cultivated it is called tchou-ma, tsu-ma, or cho-ma; and in Japan it is called mao, kusa-mao, and kari-mushi.

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Grass cloth (hsia-pu) is a woven fabric made in China chiefly from ramie, but the name is also used to designate similar fabrics made of hemp, pineapple fiber, or a combination of these fibers. The grass

FIGURE 1.—Mature ramie plants

cloth is all made in the household industries, the yarns being spun and woven by hand. The Swatow grass cloth which is best known in the United States is composed chiefly of ramie yarns, or ramie fibers laid in parallel strands and not twisted into yarns.

THE PLANT

Ramie (*Boehmeria nivea* (L.) Gaud.) is a perennial shrub. (Figs. 1 and 2.) It belongs to the Urticaceae or nettle family, but it does not have stinging hairs. It grows from perennial rootstocks which

FIGURE 2.—Ramie, 6½ feet high, grown on very fertile moist sand and silt soil. First crop of the season, ready for harvest July 23

send up herbaceous shoots or canes one-half inch or less in diameter and 3 to 7 feet high. These canes bear nearly round or heart-shaped leaves, rather thick in texture, dark green above, and woolly white on the under surface. At maturity they produce near the tops branched clusters of very small greenish yellow staminate flowers,

and later still higher up on the stems clusters of pistillate or seed-bearing flowers. (Fig. 3.) The small yellow oval seeds are less than one-twentieth inch in length.

If the shoots are cut during the growing season, others come up, so that two to four crops may be cut in one year. (Fig. 4.) Usually two or three crops are harvested each season, but the production of fiber from more than two crops in one season is not proportionately increased.

WHERE CULTIVATED

Ramie is cultivated in China and Japan and to a limited extent in India. It is said to have been one of the principal fibers used in China for making cloth previous to the introduction of cotton

FIGURE 3.—Ramie seeds borne in clusters on the upper part of the stalks, past the stage at which the stalks will yield good fiber

into that country about 1300 A. D. Since then it has been largely replaced by cotton, but it is still produced and used more in China than in all other countries combined. Nearly every Province in China grows some ramie, but the principal ramie-producing Provinces are Kiangsi, Hupeh, Hunan, and Szechwan, or those south of the Yangtze River. It is grown only in small garden plots and never as a field crop.

In Japan it is grown chiefly in Taiwan (Formosa) and to a limited extent in the western part of the island of Honshu.

In India it is cultivated in the northeastern Provinces, Bengal, and Assam. It is grown in that region almost exclusively by fishermen who have small patches of it for the production of fiber which they use for fishing lines and nets. Efforts to raise ramie as a field crop

in India for the production of fiber for export have resulted in failure.

Although the ramie plant was described from specimens from China by Linnaeus[1] in 1737, it does not seem to have been known as a fiber-producing plant west of central Asia until more than a century later. In 1869 the Government of British India offered a reward of £5,000 for a machine that would successfully decorticate ramie—that is, separate the fiber from the green stalks and clean it. A trial of machines competing for this reward, held in 1872, resulted in failure. A second trial, in 1879, also resulted in failure, and later the offer was withdrawn. Interest, however, had been aroused, and

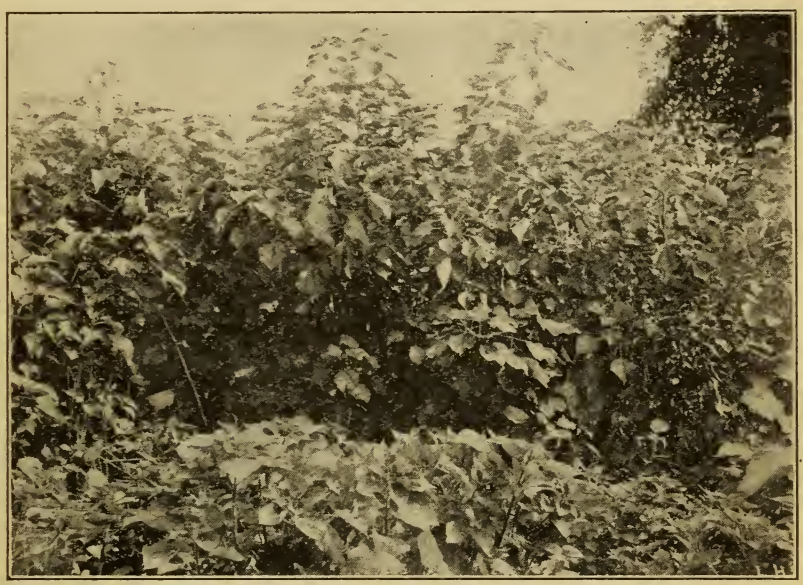

FIGURE 4.—Ramie. First crop in background, growth from April to July 23, at Washington, D. C., 6½ feet high; second crop in foreground, 16 inches high, 10 days after the first crop was cut over this part of the plot, a growth under ideal conditions of moist, rich sandy-loam soil

since that time the ramie plant has been introduced into nearly all warm countries.

It has been tried in southern Europe and especially in southern France, where it has been grown primarily to furnish material for trials of decorticating machines. Four machine trials were conducted by the French Government between 1888 and 1894, but none of the machines were regarded as satisfactory. Ramie has also been tried in Algeria, Egypt, Belgian Congo, and other countries in Africa, but none of the experiments have developed into commercial cultivation.

Ramie was first introduced into the United States about 1855. Experiments have been conducted by private individuals, State agricultural experiment stations, and the United States Department of

[1] LINNÉ, C. VON. HORTUS CLIFFORTIANUS. 501 p., illus. Amstelædami. 1737.

Agriculture in many places from New Jersey to Texas and in California. The most extensive planting experiments—never more than 40 or 50 acres in any one place—have been carried on by men who were developing decorticating machines. These experiments have indicated the conditions under which the plants grow best in this country, but without satisfactory methods for preparing the fiber they give little hope of commercial success. Experiments with similar results have been tried in Cuba, Mexico, Guatemala, and in several countries in South America. Ramie fiber is produced commercially only in China and Japan.

CLIMATE

Ramie grows best in a warm temperate climate where the winters are cool enough to induce a resting period. It does not grow as well in tropical Java as it does in China, or as well in Porto Rico as it does in the Gulf States. Its rootstocks are likely to be killed by freezing and especially in poorly drained soils by repeated freezing and thawing during the winter. It can not be grown without protection where the winters are cold enough for frost to reach the roots 5 or 6 inches below the surface of the ground. The small experimental plots at Washington, D. C., are heavily mulched late in the fall to protect the rootstocks from frost.

Ramie will survive rather severe drought after it is well established, but it requires abundant moisture to grow well enough to be of any value. In the Atlantic and Gulf States, with an annual rainfall of 40 to 50 inches, ramie may grow well on rich bottom lands. In California it has been grown under irrigation. It requires more moisture than corn, cotton, cowpeas, or most other field crops of the warm temperate region. It will not endure inundation or a water-soaked soil without serious injury.

SOILS

Ramie grows best in a very fertile sandy-loam alluvial soil having good drainage and not subject to drought. Unlike cotton, a growth of stalks rather than fruiting seed bolls is desired, and therefore rich bottom lands rather than the dry uplands are best adapted to ramie. It will not grow in undrained swamps or on stiff clays, and on light sandy soils it requires heavy fertilization.

FERTILIZER

Ramie requires a fertile soil, and since two or three crops are removed each year for five years or longer, the fertility must be kept up by rather heavy applications of stable manure or commercial fertilizer. Ramie requires more nitrogen and potash than wheat, but less phosphoric acid. The leaves contain a larger proportion of fertilizing elements than other parts of the plant, and the depletion of fertility may be avoided to some extent by returning the leaves to the soil.

PROPAGATION

Ramie is usually propagated by cuttings of the rootstocks. These are cut into pieces 5 to 7 inches long and planted in rows 3 to 4 feet

apart and about 20 inches apart in the row. They are usually placed in a slanting position and covered so that the upper end is about 2 inches below the surface. If the soil is moist and the weather warm, shoots will come up in 10 to 15 days. Entire crowns with roots attached are transplanted, making a quicker and stronger growth. Cuttings of the stems have been used to propagate ramie in some of the experimental plantings in India. Excellent results have been obtained in propagating the plants with seeds in California. The seeds were germinated and the young seedlings grown in open ground in specially prepared beds that were kept moist by frequent watering with a fine spray. The seedlings were transplanted to the field when 10 or 15 inches in height and set out in rows 40 inches apart. However, great difficulty is usually experienced in attempts to grow ramie from seeds. Often the seeds do not germinate well, and the young seedlings are especially subject to damping off. Cuttings or seedlings are set out in the fall or in early spring. They rarely survive if planted in hot, dry weather in midsummer. About two weeks after a plot is planted it should be inspected and vacancies filled with fresh cuttings or young plants.

CULTIVATION

The land between the rows is cultivated to keep down all weeds and other vegetation. In China and Japan this work is done by hand. In the United States it might be done with cultivators such as are used for corn or potatoes. The land is cultivated after each crop is harvested. If the plants are grown under irrigation they may be irrigated by the furrow method twice between crops and the land cultivated as soon as it is dry enough after each irrigation. The shoots are usually cut off once or twice during the first year after planting, to induce a thicker and better growth of canes.

HARVESTING

The first crop of ramie stalks for fiber production is usually cut in the second summer after the plants are set out, and afterwards two or three crops may be cut each year for a period of 5 to 10 years. The number of crops per year and the number of years that the plants continue to yield good crops depend largely on the original fertility of the land and the care exercised in maintaining it unimpaired.

In the principal ramie-producing regions of China, the first crop is cut in May or June and the second in July or August and in some places a third crop in October. The stalks of the first crop are taller, but they produce coarser fiber. The second and third crops contain more gum. It is all harvested by hand. In most places the leaves are stripped from the standing stalks, the bark (including the fiber) is peeled off in ribbonlike strips, and the stalks are left standing; or the stalks are cut with a knife and the bark is peeled off afterwards.

A self-rake reaper, such as is used for harvesting hemp, has been used successfully in California for harvesting ramie. Ramie is more subject to heating and molding than any other field crop grown in this country, and it would be difficult to cure the stalks in gavels if harvested with a self-rake reaper in a humid climate.

DECORTICATION

There are many variations in the methods of decortication, which includes the separation of the fiber from the stalk and cleaning it for market, but all consist essentially in stripping off the bark, including the fiber, either before or after the stalks are cut, then scraping away the thin but closely clinging brown outer bark, most of the green coloring matter, and some of the gums which have not hardened. All of this work is done by hand. In some places the stalks or the peeled ribbons are placed in running water to keep them in a fresh condition awaiting the scraping process. In most places the ribbons are scraped by drawing them between a bamboo or bone knife and a bamboo thimble worn on the thumb. The fiber, after being cleaned by scraping, is hung on rods in a small earthen cellar, where it is dried overnight by means of a charcoal fire, and the following day dried in the sun. A poorer quality is produced by drying directly in the sun and omitting the charcoal drying. The dried fiber is called China grass, and in this form it is baled and placed upon the market.

YIELD

The yield of ramie stalks and the percentage of fiber vary widely under different conditions. With proper cultivation and application of fertilizer, the yield of stalks increases up to the fourth year. Estimates of acre yields of stalks and fiber, based on numerous experiments and statements of actual yields, are given in Table 1.

TABLE 1.—*Estimates of yields per acre of ramie stalks and fiber for the first four years of growth*

Year	Acre yields of stalks and fiber (pounds)		
	Green stalks	Air-dry stalks	China grass
First	6,000	1,500	300
Second	12,000	3,000	600
Third	18,400	4,000	900
Fourth	26,400	6,000	1,300

A recent paper on ramie in China states that 70 to 80 catties per mao (600 to 700 pounds per acre) are collected in three crops. Other reports have given the general average acre yield in China as about 400 pounds.

SOURCES OF SUPPLY OF CHINA GRASS

China is practically the only source of supply of ramie in the form of China grass at the present time. It has been exported from Taiwan (Formosa), and the production there formerly went through Hong Kong. Since Taiwan was ceded by China to Japan in 1905, its products have been going to Japanese ports rather than to Hong Kong. The consumption of ramie fiber has been increasing rapidly

in Japan in recent years. Nearly nine-tenths of the total exports of ramie from China go to Japan.

A bulletin [2] issued in April, 1923, gives the exports of ramie (in piculs, 133 pounds) from each Chinese port in the years 1917 to 1921, as shown in Table 2.

TABLE 2.—*Exports of ramie from ports in China for the years 1917 to 1921, inclusive*

Port	Annual exports (piculs of 133 pounds)				
	1917	1918	1919	1920	1921
Changsha		39			
Yochow	40,480	57,070	37,428	59,590	50,791
Hankow	182,704	179,473	168,167	157,769	138,719
Kiukiang	163,455	167,989	140,280	156,520	146,524
Nanking	10				
Chinkiang		8			78
Shanghai	116	102	521	340	358
Ningpo	15	173	239	83	
Foochow		9	11		3
Swatow		88	39	94	27
Canton	12	612		6	
Wahu					74
Total:					
Piculs	386,792	405,563	346,685	374,402	336,574
Tons	25,721	26,970	23,055	24,898	22,382

Hankow and Kiukiang are the most important exporting centers in China, and much of the fiber from these interior ports passes through Hong Kong, Shanghai, or Tientsin.

The quantity of ramie consumed locally in China is not known, but it is variously estimated at from 700,000 to 1,500,000 piculs (about 45,000 to 100,000 tons). It is practically impossible, even with the published statistics, to obtain any accurate data, because of the confusion of names. The statistics in some of the Provinces are given for ramie alone, while in others they may include hemp, chingma, and jute.

IMPORTATIONS

Ramie is not listed separately in the statistics of importations into the United States. The exports of ramie to this country as given in the Chinese bulletin [2] referred to for the years 1912 to 1920 are shown in Table 3.

TABLE 3.—*Imports of ramie into the United States from China, 1912–1920*

Year	Pounds	Year	Pounds	Year	Pounds
1912	1,075,970	1915	823,536	1918	3,560,011
1913	130,074	1916	743,002	1919	48,811
1914	224,371	1917	2,668,113	1920	4,389

[2] CHINESE GOVERNMENT BUREAU OF ECONOMIC INFORMATION. RAMIE, THE CHINA GRASS. Chinese Govt. Bur. Econ. Inform. Bul. (ser. 2) 26, 9 p. 1923.

PRICES

Ramie is not quoted in the fiber markets of the United States. It is quoted by fiber merchants in London. The London quotations for China grass for the years 1918 to 1928 are shown in Table 4.

TABLE 4.—*London quotations for China grass, 1918–1928*

Year	Quotations per ton		Year	Quotations per ton	
	Highest	Lowest		Highest	Lowest
1918	£160	£80	1923	£78	£56
1919	120	54	1924	72	59
1920	160	75	1925	75	59
1921	75	56	1926	66	52
1922	78	62	1927	58	48

Previous to 1914 the prices of ramie fiber in the form of China grass ranged from about 8 to 14 cents a pound delivered at American ports.

DEGUMMING

The process of degumming consists in dissolving and removing the gums which surround the ramie fibers and bind them together and also in removing the parenchyma or thin-walled tissues surrounding the fibers. It corresponds to retting in flax, hemp, and jute, but the ramie gums are different and are not removed by the same treatment. Ramie fiber is degummed after it has been removed from the stalks in the form of China grass. It is a process of manufacture and not of production. Ramie spinners in the United States and Europe state that they prefer to receive the fiber in the form of China grass rather than the degummed filasse. Most of the degumming processes consist of treatment with alkaline and acid solutions followed by washing in water. It is not difficult to devise chemical treatments that will dissolve the gums, but it is very difficult to devise treatments that will eliminate the gums without injuring the fiber. The chemically degummed ramie is rarely as durable as that prepared in China by repeated washing in water and bleaching in the sun.

MANUFACTURE

After being degummed and bleached, usually in the same operation, the fiber is dried and becomes a white lustrous filasse. This is combed, the long fibers, 3 to 6 inches long, called tops, are straightened out, and the short or tangled fibers, called noils, are separated from them. The fibers in the noils range from three-eighths inch to 3 inches in length. Owing to lack of uniformity they are of little value for textile purposes. Ramie fibers average about twice the diameter of flax fibers, and while the individual fibers have excellent strength, they do not cling together as well as flax or cotton when twisted into yarn. Ramie fibers have a tendency to fly apart, and when spun into yarn, the ends of the fibers stick out, making a fuzzy yarn. Special processes are required for preparing ramie fiber in the mill, and special machinery is required for spinning the prepared filasse.

USES

Ramie yarns produced in the United States, England, and France have been used chiefly in the manufacture of incandescent gas mantles. A wide variety of woven fabrics are made by a factory at Emmendingen, Germany. Tablecloths, napkins, plushes, covering for upholstered furniture, curtains, carpets, dress goods, and knit goods are made of ramie fiber. In China this fiber is used for various fabrics similar to our linens, and especially for fishing lines, laces, mosquito nets, summer clothing, and grass cloth of various kinds. The Swatow grass cloth, used in embroidery or drawn-work doilies, table covers, and the like, is probably better known in America than any other ramie fabric made in China.

PHYSICAL PROPERTIES OF THE FIBER

When thoroughly degummed and combed a large proportion of the ramie fibers are reduced to their ultimate cells. Flax and other bast fibers are rarely reduced to their ultimate cells in preparing them for spinning. Unlike the single cells of cotton, the cells of ramie lack uniformity. The larger ramie cells are longer than those of any other textile fiber of commerce. They range from about one-half to 10 or even 20 inches in length, averaging about 6 or 8 inches, and 20/10,000 to 30/10,000 inch in diameter. The ultimate cells of flax fiber range from one-half to 2½ inches in length, averaging about 1¼ inches, and 6/10.000 to 15/10,000 inch in diameter. The chief physical properties of ramie fiber as compared with other textile fibers, as given by Matthews,[3] are shown in Table 5.

TABLE 5.—*Chief physical properties of ramie fiber as compared with other textile fibers*

Physical property	Comparison of fibers (ramie rated as 100)				
	Ramie	Hemp	Flax	Silk	Cotton
Tension	100	36	25	13	12
Elasticity	100	75	66	400	100
Torsion	100	95	80	600	400

Ramie has excellent strength as compared with the other fibers, but it is rather poor in elasticity and, as compared with silk, is very poor in torsion, that is, it has slight ability to resist strain when bent or sharply twisted. It absorbs water more quickly than flax and also dries out more quickly, but it is affected very little by moisture. The fiber itself has a high luster, but this is often obscured in woven goods by the projecting ends of the fibers in the yarns. Recent experiments in England indicate that by a treatment somewhat in the nature of mercerizing, without tension in drying, the fiber may be prepared so as to be spun more smoothly. Unless it can be treated in some manner to improve its resistance under torsion, it is very improbable that it can be used successfully for automobile tires, belting, or other mechanical fabrics.

[3] MATTHEWS, J. M. THE TEXTILE FIBERS, THEIR PHYSICAL, MICROSCOPICAL, AND CHEMICAL PROPERTIES. Ed. 4, rewritten and enl., 1,053 p., illus. New York and London. 1924.

SUMMARY

Ramie, occasionally referred to as rameh or rhea, is cultivated commercially only in China and Japan. It has been grown in various other countries but only for experimental purposes. It grows in a warm temperate climate with abundant rainfall and requires very fertile well-drained soil. China is the only source of supply of ramie fiber, and the importations of this product into the United States are small.

All the work of propagation, cultivation, harvesting, and preparation of the fiber is done by hand. Ramie is a remarkably strong fiber, adapted to many uses, but is not readily spun on spinning machinery designed for other fibers. Degumming corresponds to retting of flax and hemp and is a process in the manufacture rather than in the production of ramie.

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